US009343854B2

(12) **United States Patent**
Nakamura et al.

(10) **Patent No.: US 9,343,854 B2**
(45) **Date of Patent: May 17, 2016**

(54) **COAXIAL CONNECTOR PLUG**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 22 days.

(21) Appl. No.: **14/447,520**

(22) Filed: **Jul. 30, 2014**

(65) **Prior Publication Data**

US 2015/0118900 A1 Apr. 30, 2015

(30) **Foreign Application Priority Data**

Oct. 29, 2013 (JP) 2013-224046

(51) **Int. Cl.**
H01R 24/38 (2011.01)
H01R 12/73 (2011.01)
H01R 103/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01R 24/38*** (2013.01); ***H01R 12/73*** (2013.01); *H01R 2103/00* (2013.01)

(58) **Field of Classification Search**
USPC 439/63, 188, 83, 248; 29/876; 174/262
See application file for complete search history.

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(57) **ABSTRACT**

A coaxial connector plug includes a first outer conductive unit that includes a first outer conductor that has a substantially ring-like shape in a portion of which a cutting portion is formed when viewed in plan and first and second outer terminals that are drawn out downwardly from the first outer conductor and a first central conductive unit that includes a first central conductor disposed in an area surrounded by the first outer conductor when viewed in plan. The first and second outer terminals are disposed, when viewed in plan from above, further toward the side on which the cutting portion is formed than a second line with the cutting portion interposed between the first and second outer terminals, the second line being perpendicular to a first line, which connects the center of the first outer conductor and the cutting portion, and passing through the center.

7 Claims, 16 Drawing Sheets

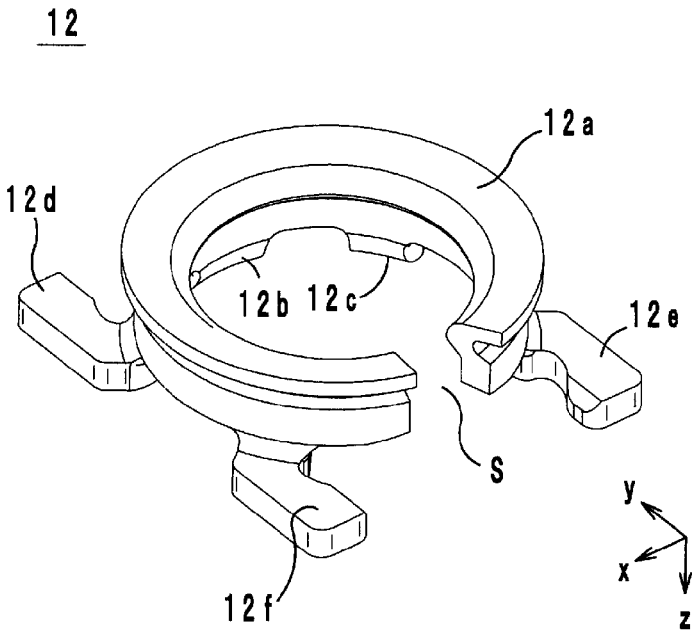


FIG. 1

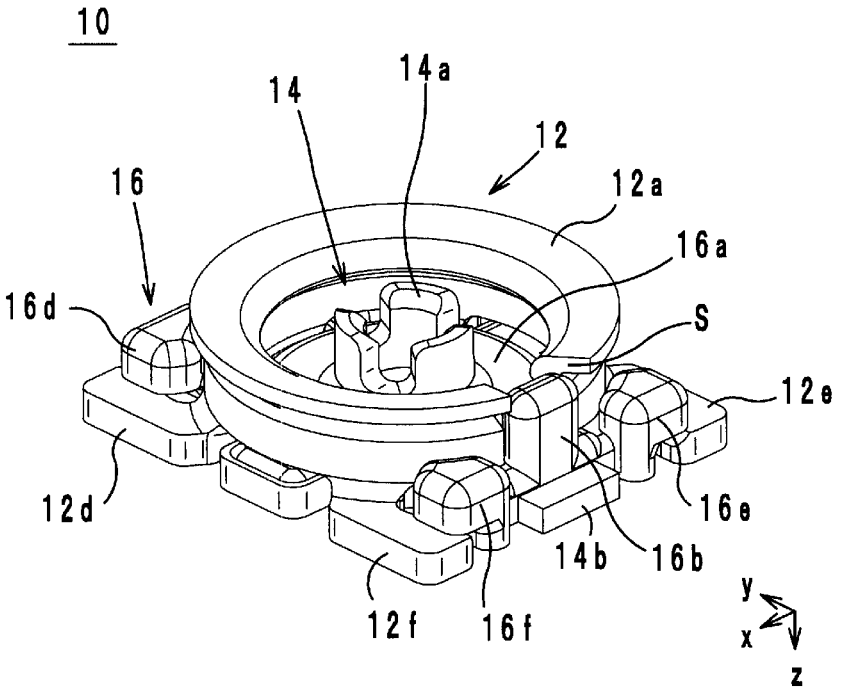


FIG. 2

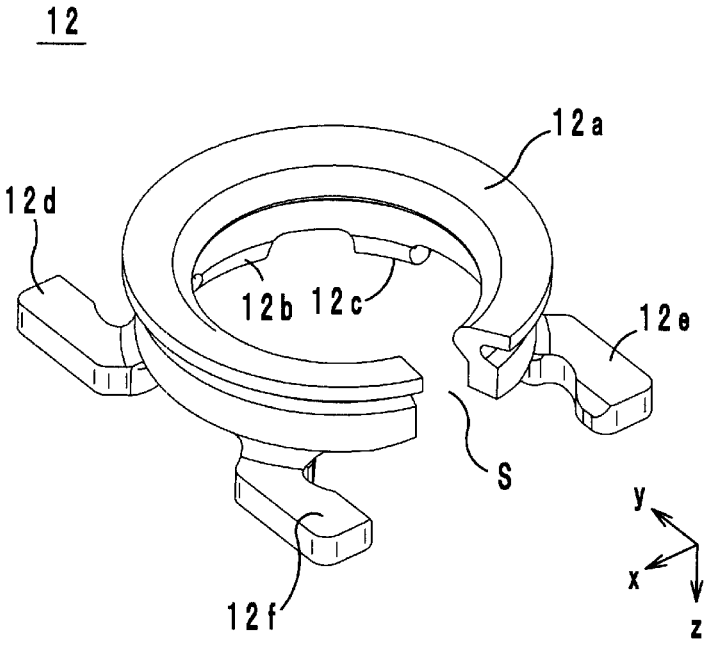


FIG. 3

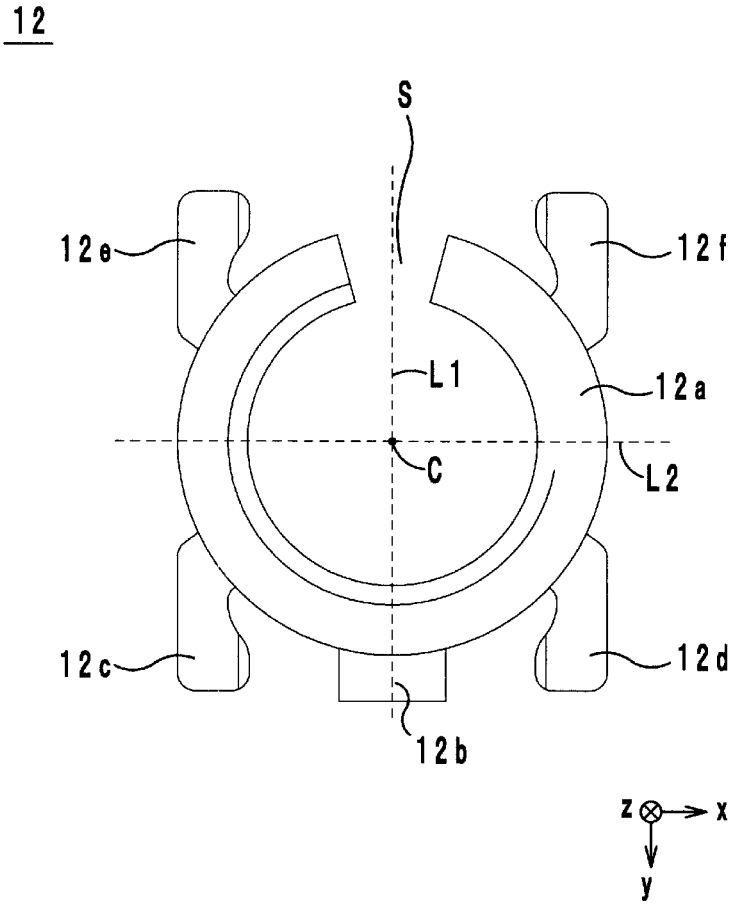


FIG. 4

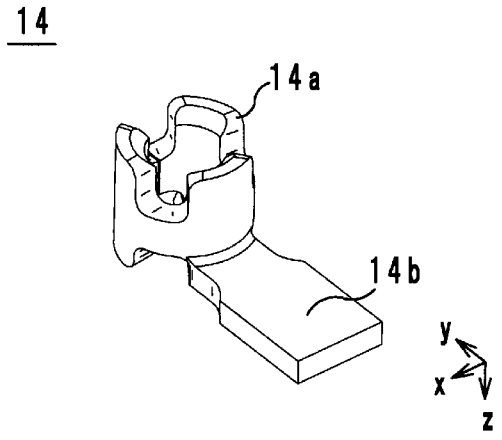


FIG. 5

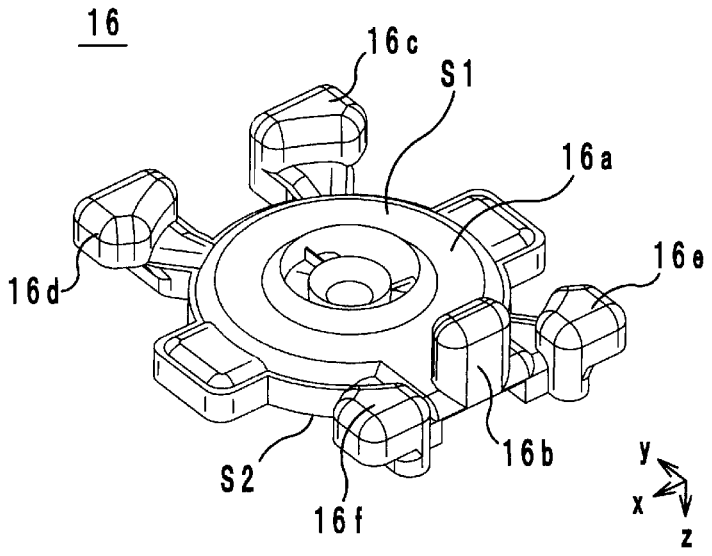


FIG. 6

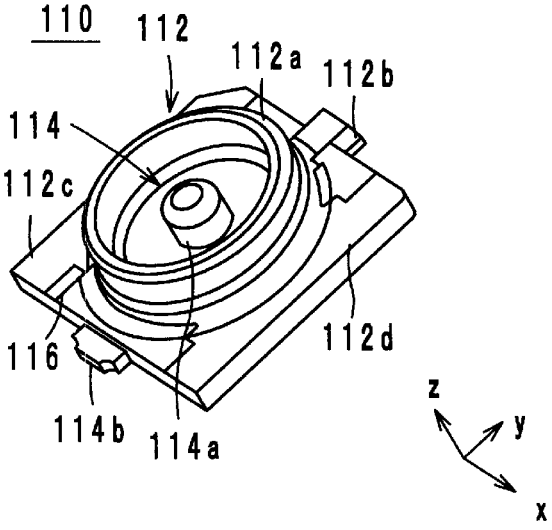


FIG. 7

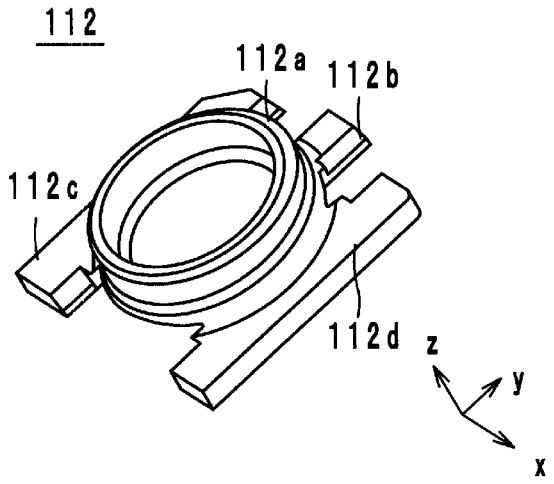


FIG. 8

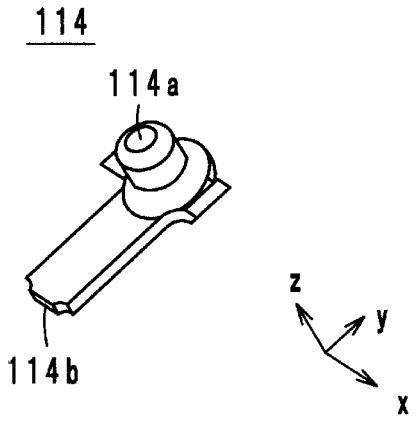


FIG. 9

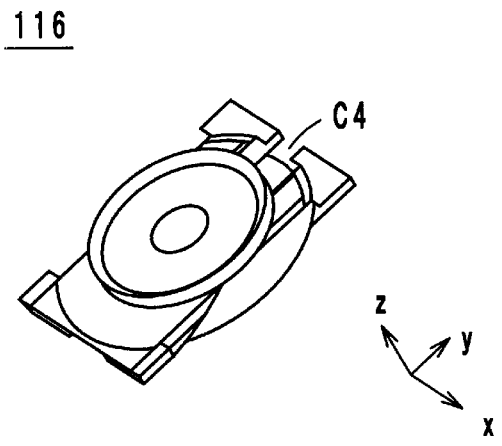


FIG. 10

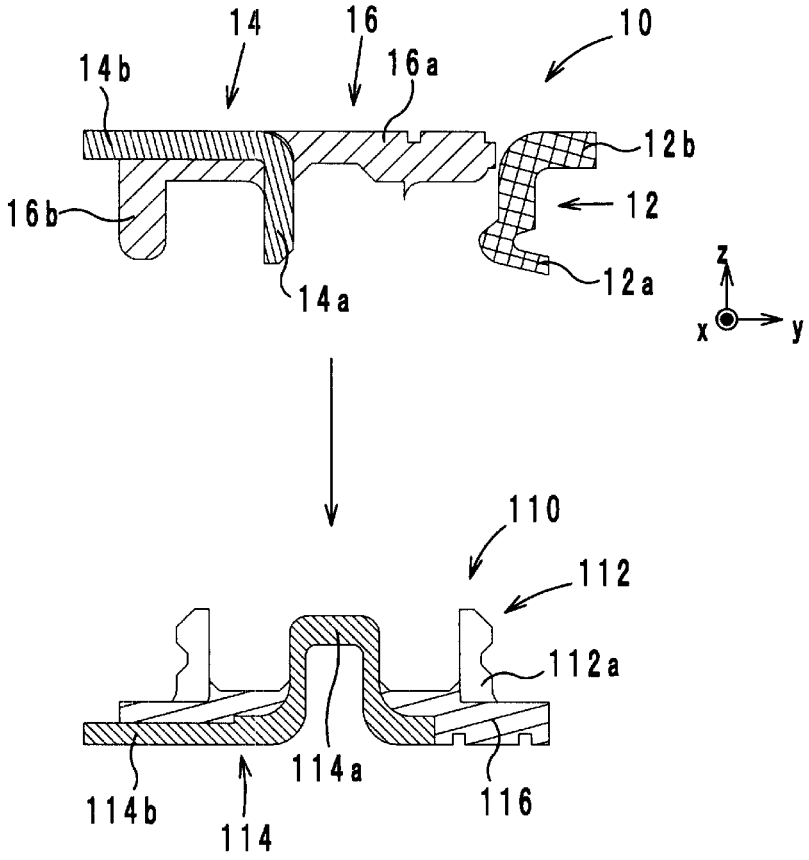

14
16
10
14b
16a
12b
16b
12
14a
12a
z
x
y
110
112
112a
114a
114b
114
116

FIG. 11

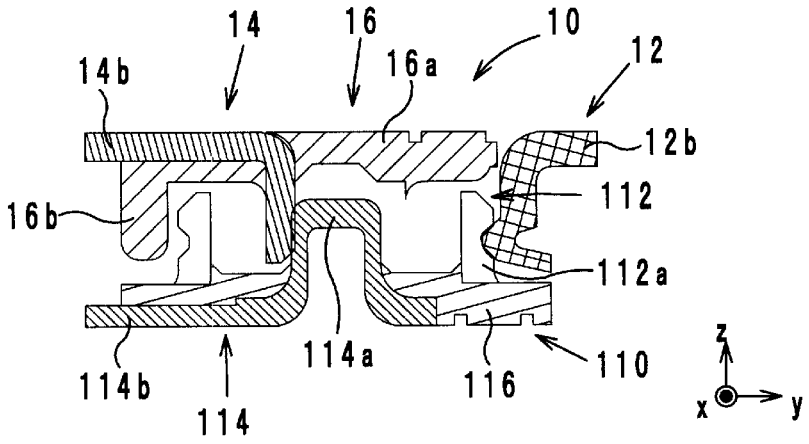


FIG. 12

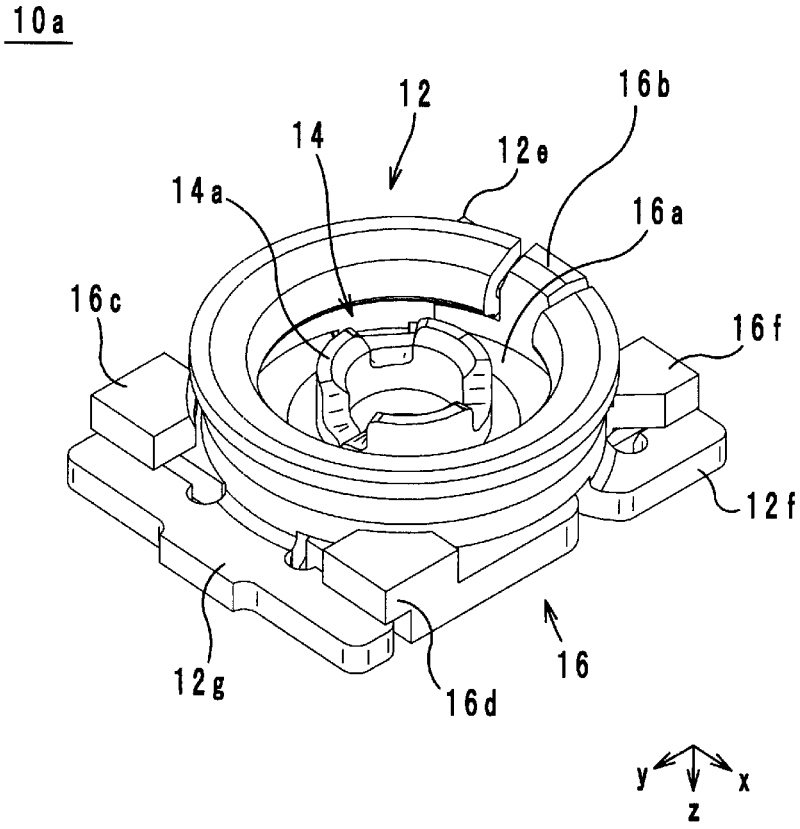


FIG. 13

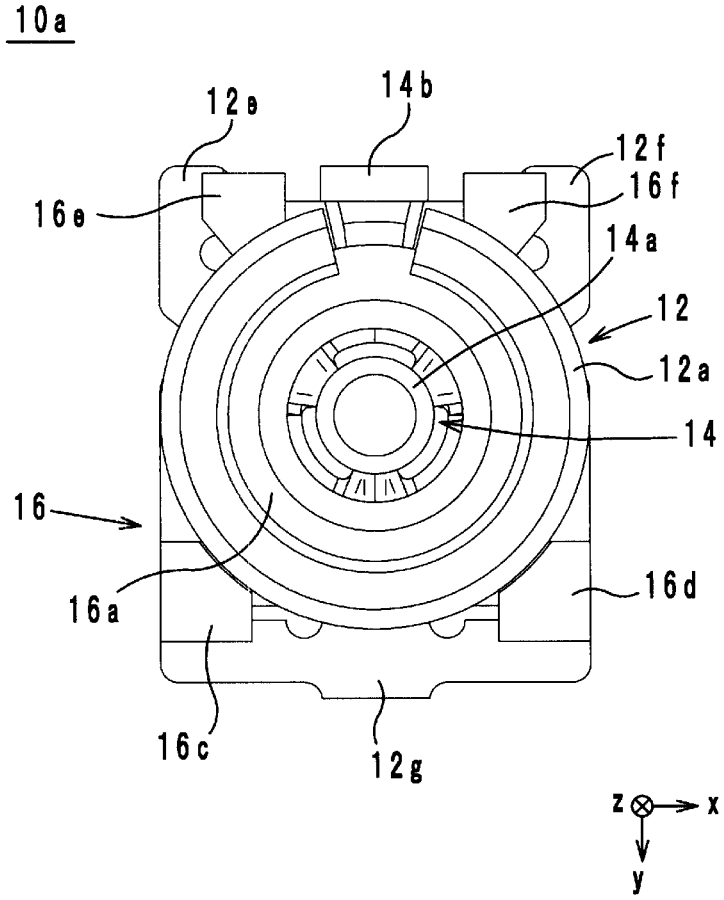


FIG. 14

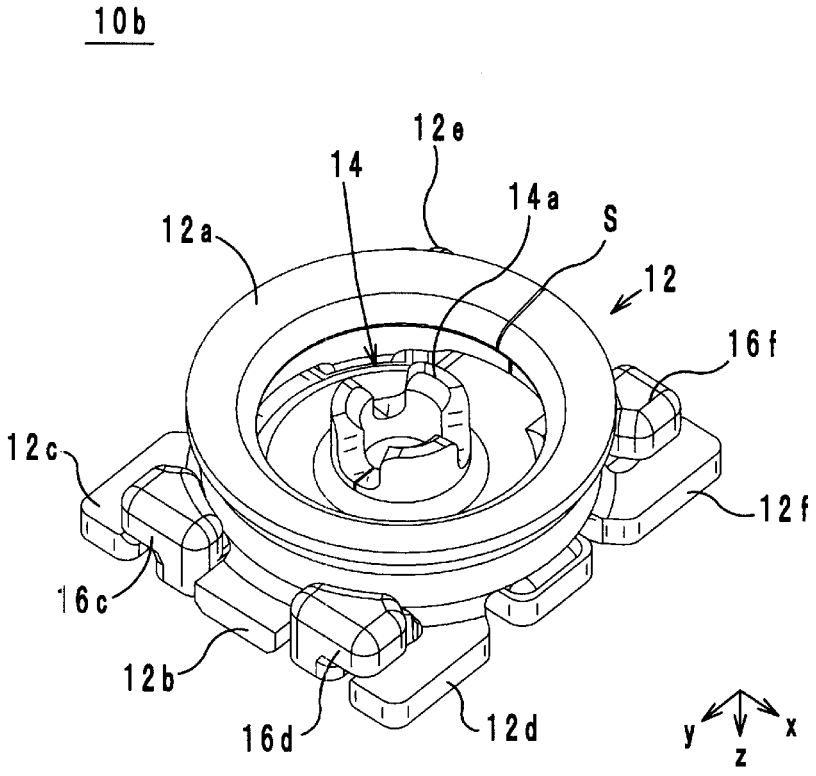


FIG. 15

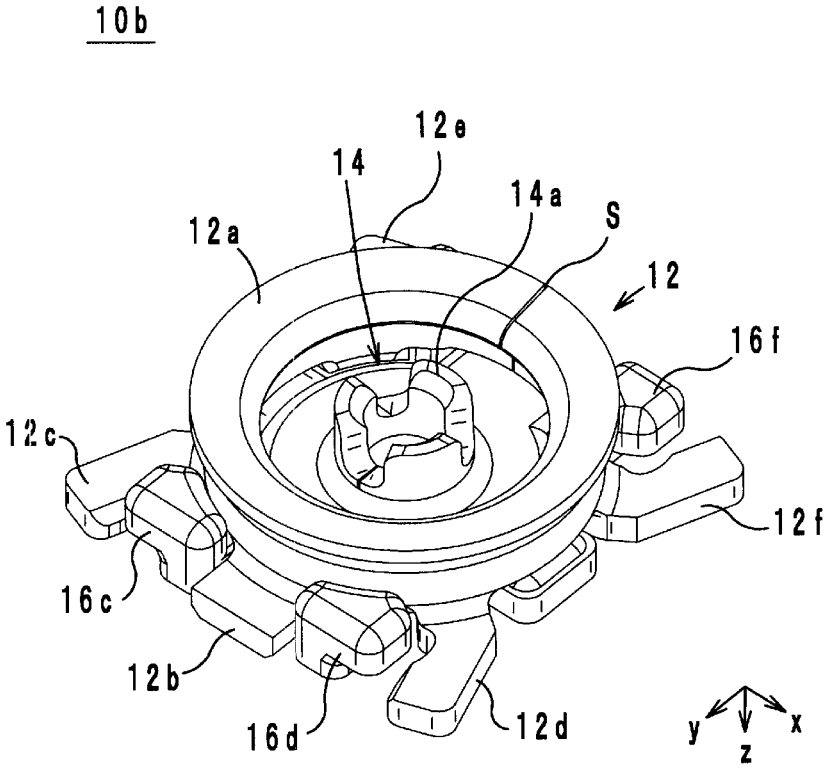
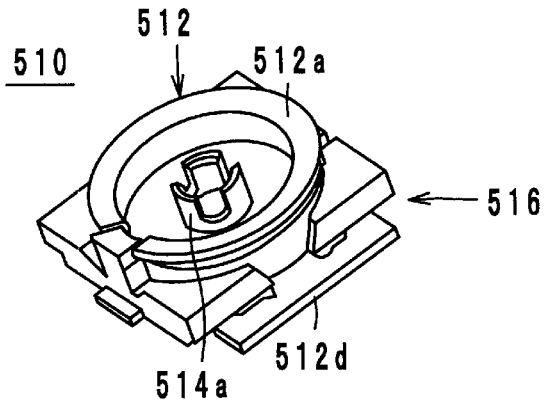


FIG. 16
PRIOR ART



COAXIAL CONNECTOR PLUG

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims benefit of priority to Japanese Patent Application No. 2013-224046 filed on Oct. 29, 2013, the entire content of which is incorporated herein by reference.

TECHNICAL FIELD

The present technical field relates to coaxial connector plugs, and more particularly, to a coaxial connector plug that includes an outer conductor that is substantially ring-shaped, a portion of the outer conductor being cut off in such a manner as to form a cutting portion.

BACKGROUND

A coaxial connector plug described in Japanese Unexamined Patent Application Publication No. 2013-118121 is a known example of a coaxial connector plug of the related art. FIG. **16** is an outer perspective view of a coaxial connector plug **510** described in Japanese Unexamined Patent Application Publication No. 2013-118121.

As illustrated in FIG. **16**, the coaxial connector plug **510** includes an outer conductive unit **512**, a central conductor **514***a*, and an insulator **516**. The outer conductive unit **512** includes an outer conductor **512***a* and outer terminals **512***c* and **512***d*. Note that the outer terminal **512***c* is not illustrated in FIG. **16** because the outer terminal **512***c* is covered by the outer conductor **512***a*.

The outer conductor **512***a* has a shape that is substantially cylindrical and that extends in the top-bottom direction. The outer terminals **512***c* and **512***d* are drawn out beneath the outer conductor **512***a*, bent in a direction away from the outer conductor **512***a*, and disposed so as to face each other with the outer conductor **512***a* interposed therebetween as seen from above in plan view.

The insulator **516** has a substantially plate-like shape that has a pair of sides that oppose each other. A lower end of the outer conductor **512***a* is in contact with a top surface of the insulator **516**, and a pair of sides of each of a pair of the outer terminals **512***c* and **512***d* are in contact with a bottom surface of the insulator **516**, so that the insulator **516** is sandwiched by the outer conductive unit **512** in the top-bottom direction. The central conductor **514***a* is mounted on the insulator **516** and disposed in an area surrounded by the outer conductor **512***a*.

A coaxial connector receptacle is to be mounted on the coaxial connector plug **510**, which has the above-described configuration. More specifically, the coaxial connector receptacle includes an outer conductor that has a substantially cylindrical-like shape and a central conductor that is disposed at the center of the outer conductor. The outer conductor of the coaxial connector receptacle is to be inserted into the outer conductor **512***a* of the coaxial connector plug **510**. In this case, the central conductor **514***a* of the coaxial connector plug **510** and the central conductor of the coaxial connector receptacle are connected to each other. In addition, elastic deformation occurs in the outer conductor **512***a* in such a manner that a cutting portion that has been formed in the outer conductor **512***a* is slightly widened, and the outer conductor **512***a* is pressed into contact with the outer peripheral surface of the outer conductor of the coaxial connector receptacle. As a result, the coaxial connector plug **510** and the coaxial connector receptacle are fixed to each other.

There has been a demand for a reduction in the height of the coaxial connector plug **510**. Therefore, the height of the outer conductor **512***a* has been decreasing year-by-year. However, as the height of the outer conductor **512***a* in the top-bottom direction decreases, the rigidity of the outer conductor **512***a* decreases. Accordingly, the outer conductor **512***a* cannot be pressed into contact with the outer peripheral surface of the outer conductor of the coaxial connector receptacle with sufficient strength. As a result, the coaxial connector plug **510** easily separates from the coaxial connector receptacle.

SUMMARY

Accordingly, it is an object of the present disclosure to provide a coaxial connector plug that can reduce the probability of being easily separated from a coaxial connector receptacle.

According to a preferred embodiment of the present disclosure, there is provided a coaxial connector plug including a first outer conductive unit that includes a first outer conductor that has a substantially ring-like shape in a portion of which a cutting portion is formed when viewed in plan from above and a first outer terminal and a second outer terminal that are drawn out downwardly from the first outer conductor and a first central conductive unit that includes a first central conductor that is disposed in an area surrounded by the first outer conductor when viewed in plan from above. The first outer terminal and the second outer terminal are disposed, when viewed in plan from above, further toward a side on which the cutting portion is formed than a second line with the cutting portion interposed between the first outer terminal and the second outer terminal, the second line being perpendicular to a first line, which connects the center of the first outer conductor and the cutting portion, and passing through the center.

According to a preferred embodiment of the present disclosure, the probability of a coaxial connector plug easily separating from a coaxial connector receptacle can be reduced.

Other features, elements, characteristics and advantages of the present disclosure will become more apparent from the following detailed description of preferred embodiments of the present disclosure with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an outer perspective view of a coaxial connector plug **10** according to an embodiment of the present disclosure.

FIG. **2** is an external perspective view of an outer conductive unit **12** of the coaxial connector plug **10**.

FIG. **3** is a diagram illustrating the outer conductive unit **12** when viewed in plan in the z-axis direction.

FIG. **4** is an external perspective view of a central conductive unit **14** of the coaxial connector plug **10**.

FIG. **5** is an external perspective view of an insulator **16** of the coaxial connector plug **10**.

FIG. **6** is an external perspective view of a coaxial connector receptacle **110** according to the embodiment of the present disclosure.

FIG. **7** is an external perspective view of an outer conductive unit **112** of the coaxial connector receptacle **110**.

FIG. **8** is an external perspective view of a central conductive unit **114** of the coaxial connector receptacle **110**.

FIG. **9** is an external perspective view of an insulator **116** of the coaxial connector receptacle **110**.

FIG. **10** is a diagram illustrating the sectional structures of the coaxial connector plug **10** and the coaxial connector receptacle **110** before the coaxial connector receptacle **110** is mounted on the coaxial connector plug **10**.

FIG. **11** is a diagram illustrating the sectional structures of the coaxial connector plug **10** and the coaxial connector receptacle **110** after the coaxial connector receptacle **110** has been mounted on the coaxial connector plug **10**.

FIG. **12** is an external perspective view of a coaxial connector plug **10***a* according to a first modification.

FIG. **13** is a diagram illustrating the coaxial connector plug **10***a* according to the first modification when viewed in plan in the z-axis direction.

FIG. **14** is an external perspective view of a coaxial connector plug **10***b* according to a second modification.

FIG. **15** is an external perspective view of the coaxial connector plug **10***b* according to the second modification during a process of manufacturing the coaxial connector plug.

FIG. **16** is an external perspective view of the coaxial connector plug **510** described in Japanese Unexamined Patent Application Publication No. 2013-118121.

DETAILED DESCRIPTION

A coaxial connector plug according to an embodiment of the present disclosure will be described below.

Configuration of Coaxial Connector Plug

First, the coaxial connector plug according to the embodiment of the present disclosure will be described with reference to FIG. **1** to FIG. **5**. FIG. **1** is an outer perspective view of a coaxial connector plug **10** according to the embodiment of the present disclosure. FIG. **2** is an external perspective view of an outer conductive unit **12** of the coaxial connector plug **10**. FIG. **3** is a diagram illustrating the outer conductive unit **12** when viewed in plan in the z-axis direction. FIG. **4** is an external perspective view of a central conductive unit **14** of the coaxial connector plug **10**. FIG. **5** is an external perspective view of an insulator **16** of the coaxial connector plug **10**.

A coaxial connector receptacle, which will be described later, is to be mounted on the coaxial connector plug **10** from below. In other words, when the coaxial connector plug **10** is used, the coaxial connector plug **10** is used in a state where an opening thereof faces downward. Note that, for convenience of description, the upward direction in FIG. **1** is a direction towards the upper side in the vertical direction, and the downward direction in FIG. **1** is a direction towards the lower side in the vertical direction. In addition, the downward direction in FIG. **1** is defined as the positive side in the z-axis direction, and the upward direction in FIG. **1** is defined as the negative side in the z-axis direction.

The coaxial connector plug **10** has a substantially rectangular shape when viewed in plan in the z-axis direction. A direction in which one of two sides of the coaxial connector plug **10** extends and a direction in which the other one of the two sides of the coaxial connector plug **10** extends when the coaxial connector plug **10** is viewed in plan in the z-axis direction are defined as the x-axis direction and the y-axis direction, respectively. The x-axis direction, the y-axis direction, and the z-axis direction are perpendicular to one another.

The coaxial connector plug **10** is to be mounted on a circuit board such as a flexible printed circuit board, and as illustrated in FIG. **1** and FIG. **2**, the coaxial connector plug includes the outer conductive unit **12**, the central conductive unit **14**, and the insulator **16**.

The outer conductive unit **12** is fabricated by performing punching and bending on a single metallic sheet (which is, for example, made of phosphor bronze) that has conductivity and elasticity. In addition, the outer conductive unit **12** is plated with nickel, silver, or gold. As illustrated in FIG. **1** to FIG. **3**, the outer conductive unit **12** includes an outer conductor **12***a* and outer terminals **12***b* to **12***f*. As illustrated in FIG. **1** to FIG. **3**, the outer conductor **12***a* has a shape that is substantially cylindrical and that extends in the z-axis direction.

In addition, as illustrated in FIG. **1** to FIG. **3**, the outer conductor **12***a* has a substantially ring-like shape in a portion of which a cutting portion S is formed when viewed in plan in the z-axis direction. In the outer conductor **12***a*, the cutting portion S extends in the z-axis direction. In addition, the outer conductor **12***a* has a configuration in which the outer conductor **12***a* is open at the cutting portion S and has a so-called substantially C-like shape. In the following description, as illustrated in FIG. **3**, the center of the outer conductor **12***a* when the outer conductor **12***a* is viewed in plan in the z-axis direction will be referred to as a center C. A straight line that connects the center C and the cutting portion S will be referred to as a straight line L**1**. Note that the straight line L**1** passes through the center of the cutting portion S. A straight line that passes through the center C and that is perpendicular to the straight line L**1** will be referred to as a straight line L**2**. The straight line L**1** is parallel to the y-axis direction, and the straight line L**2** is parallel to the x-axis direction.

As illustrated in FIG. **2** and FIG. **3**, the outer terminals **12***b* to **12***f* are connected to the outer conductor **12***a*. The outer terminals **12***b* to **12***f* are drawn out from the outer conductor **12***a* toward the positive side in the z-axis direction and extend in a direction away from the outer conductor **12***a* when viewed in plan in the z-axis direction.

The outer terminal **12***b* is drawn out from the outer conductor **12***a* toward the positive side in the z-axis direction and bent toward the positive side in the y-axis direction. More specifically, the outer terminal **12***b* is connected to the outer conductor **12***a* at a position on the positive side in the y-axis direction with respect to the center C when viewed in plan in the z-axis direction and extends in a direction opposite to a direction from center C toward the cutting portion S (i.e., toward the positive side in the y-axis direction).

As illustrated in FIG. **1** to FIG. **3**, the outer terminals **12***c* and **12***d* are disposed further toward the side opposite to the side on which the cutting portion S is formed (i.e., the positive side in the y-axis direction) than the straight line L**2** when viewed in plan in the z-axis direction. More specifically, as illustrated in FIG. **3**, when viewed in plan in the z-axis direction, the outer terminal **12***c* is connected to the outer conductor **12***a* at a position where the cutting portion S would be if the outer conductor **12***a* were to be rotated about 135 degrees about the center C in a counterclockwise direction. In addition, the outer terminal **12***c* is drawn out from the outer conductor **12***a* to the positive side in the z-axis direction. Furthermore, the outer terminal **12***c* extends in a direction from the center C toward a portion in which the outer terminal **12***c* and the outer conductor **12***a* are connected to each other and is bent toward the positive side in the y-axis direction when viewed in plan in the z-axis direction.

On the other hand, as illustrated in FIG. **3**, when viewed in plan in the z-axis direction, the outer terminal **12***d* is connected to the outer conductor **12***a* at a position where the cutting portion S would be if the outer conductor **12***a* were to be rotated about 135 degrees about the center C in a clockwise direction. The outer terminal **12***d* is drawn out from the outer conductor **12***a* to the positive side in the z-axis direction. In addition, the outer terminal **12***d* extends in a direction from the center C toward a portion in which the outer terminal **12***d* and the outer conductor **12***a* are connected to each other and

is bent toward the positive side in the y-axis direction when viewed in plan in the z-axis direction.

As illustrated in FIG. **1** to FIG. **3**, the outer terminals **12***e* and **12***f* are disposed further toward the side on which the cutting portion S is formed (i.e., the negative side in the y-axis direction) than the straight line L**2** with the cutting portion S interposed therebetween when viewed in plan in the z-axis direction. More specifically, as illustrated in FIG. **3**, when viewed in plan in the z-axis direction, the outer terminal **12***e* is connected to the outer conductor **12***a* at a position where the cutting portion S would be if the outer conductor **12***a* were to be rotated about 45 degrees about the center C in a counterclockwise direction. In addition, the outer terminal **12***e* is drawn out from the outer conductor **12***a* to the positive side in the z-axis direction. Furthermore, the outer terminal **12***e* extends in a direction from the center C toward a portion in which the outer terminal **12***e* and the outer conductor **12***a* are connected to each other and is bent toward the negative side in the y-axis direction when viewed in plan in the z-axis direction.

On the other hand, as illustrated in FIG. **3**, when viewed in plan in the z-axis direction, the outer terminal **12***f* is connected to the outer conductor **12***a* at a position where the cutting portion S would be if the outer conductor **12***a* were to be rotated about 45 degrees about the center C in a clockwise direction. The outer terminal **12***f* is drawn out from the outer conductor **12***a* to the positive side in the z-axis direction. In addition, the outer terminal **12***f* extends in a direction from the center C toward a portion in which the outer terminal **12***f* and the outer conductor **12***a* are connected to each other and is bent toward the negative side in the y-axis direction when viewed in plan in the z-axis direction.

As illustrated in FIG. **3**, when viewed in plan in a direction in which the straight line L**1** extends (i.e., the y-axis direction), the outer terminals **12***c* to **12***f*, which have the above-described configurations, do not project out from the outer conductor **12***a* in a direction in which the straight line L**2** extends (i.e., the x-axis direction).

The central conductive unit **14** is fabricated by performing punching and bending on a single metallic sheet (which is, for example, made of phosphor bronze). In addition, the central conductive unit **14** is plated with nickel, silver, or gold. As illustrated in FIG. **1** and FIG. **4**, the central conductive unit **14** includes a central conductor **14***a* and an outer terminal **14***b*.

As illustrated in FIG. **1**, the central conductor **14***a* is disposed in an area surrounded by the outer conductor **12***a* (more specifically, at the position of the center C of the outer conductor **12***a*) when viewed in plan in the z-axis direction. In addition, as illustrated in FIG. **4**, the central conductor **14***a* has a shape that is substantially cylindrical and that extends in the z-axis direction. Three cutting portions that extend in the top-bottom direction are formed in the central conductor **14***a*. With this configuration, the central conductor **14***a* can be slightly widened in the horizontal direction. As illustrated in FIG. **4**, the outer terminal **14***b* is connected to an end portion of the central conductor **14***a* on the positive side in the z-axis direction and linearly extends toward the negative side in the y-axis direction.

The insulator **16** is made of an insulating material such as a resin, and as illustrated in FIG. **5**, the insulator **16** includes a base portion **16***a*, a projection **16***b*, and engagement portions **16***c* to **16***f*. As illustrated in FIG. **5**, the base portion **16***a* is a plate member having a substantially circular shape when viewed in plan in the z-axis direction. Note that a major surface of the base portion **16***a* on the negative side in the z-axis direction will be referred to as a top surface S**1**, and a major surface of the base portion **16***a* on the positive side in the z-axis direction will be referred to as a bottom surface S**2**.

The projection **16***b* is disposed on the negative side in the y-axis direction with respect to the base portion **16***a* and projects toward the negative side in the z-axis direction with respect to the base portion **16***a*.

The engagement portions **16***c* to **16***f* radially project from the base portion **16***a* when viewed in plan in the z-axis direction. More specifically, the engagement portion **16***c* extends from the base portion **16***a* toward the positive side in the y-axis direction and the negative side in the x-axis direction. The engagement portion **16***d* extends from the base portion **16***a* toward the positive side in the y-axis direction and the positive side in the x-axis direction. The engagement portion **16***e* extends from the base portion **16***a* toward the negative side in the y-axis direction and the negative side in the x-axis direction. The engagement portion **16***f* extends from the base portion **16***a* toward the negative side in the y-axis direction and the positive side in the x-axis direction.

The central conductive unit **14** is mounted on the insulator **16**. More specifically, as illustrated in FIG. **1**, the central conductive unit **14** and the insulator **16** are integrally molded by insert molding. Thus, the central conductor **14***a* projects toward the negative side in the z-axis direction at the center of the base portion **16***a*. In addition, the outer terminal **14***b* of the central conductive unit **14** is drawn out from the insulator **16** toward the negative side in the y-axis direction at a portion of the projection **16***b* on the positive side in the z-axis direction.

The outer conductive unit **12** is mounted on the insulator **16**. More specifically, as illustrated in FIG. **1**, an end portion of the outer conductor **12***a* on the positive side in the z-axis direction is in contact with the top surface S**1** of the base portion **16***a*. The outer terminals **12***c* to **12***f* engage with the engagement portions **16***c* to **16***f*, respectively. More specifically, the outer terminal **12***c* is drawn out from the negative side in the x-axis direction with respect to the engagement portion **16***c* toward the positive side in the z-axis direction with respect to the engagement portion **16***c*. The outer terminal **12***d* is drawn out from the positive side in the x-axis direction with respect to the engagement portion **16***d* toward the positive side in the z-axis direction with respect to the engagement portion **16***d*. The outer terminal **12***e* is drawn out from the negative side in the x-axis direction with respect to the engagement portion **16***e* toward the positive side in the z-axis direction with respect to the engagement portion **16***e*. The outer terminal **12***f* is drawn out from the positive side in the x-axis direction with respect to the engagement portion **16***f* toward the positive side in the z-axis direction with respect to the engagement portion **16***f*. The outer terminal **12***b* is drawn out toward the positive side in the z-axis direction with respect to the insulator **16** between the engagement portion **16***c* and the engagement portion **16***d*. With this configuration, the insulator **16** is mounted on the outer conductor **12***a* on the positive side in the z-axis direction.

As illustrated in FIG. **1**, the projection **16***b* is positioned within the cutting portion S. In other words, the projection **16***b* functions as a cover member that fills the cutting portion S. However, the projection **16***b* is not in contact with the outer conductor **12***a*. In other words, there is a small gap between the projection **16***b* and the outer conductor **12***a*. This enables the outer conductor **12***a* to become slightly deformed in a direction in which the diameter thereof decreases.

Coaxial Connector Receptacle

A coaxial connector receptacle that is to be mounted on the coaxial connector plug **10** according to the embodiment of the present disclosure will now be described with reference to FIG. **6** to FIG. **9**. FIG. **6** is an external perspective view of a

coaxial connector receptacle **110** according to the embodiment of the present disclosure. FIG. **7** is an external perspective view of an outer conductive unit **112** of the coaxial connector receptacle **110**. FIG. **8** is an external perspective view of a central conductive unit **114** of the coaxial connector receptacle **110**. FIG. **9** is an external perspective view of an insulator **116** of the coaxial connector receptacle **110**.

In the following description, a direction normal to a surface of the insulator **116** in FIG. **6** is defined as the z-axis direction, and when viewed in plan in the z-axis direction, a direction that is parallel to one of two sides of the insulator **116** and a direction that is parallel to the other one of the two sides of the insulator **116** are defined as the x-axis direction and the y-axis direction, respectively. The x-axis direction, the y-axis direction, and the z-axis direction are perpendicular to one another. In addition, the z-axis direction is the vertical direction.

However, the coaxial connector receptacle **110** is to be mounted on the coaxial connector plug **10** from below. In other words, when the coaxial connector receptacle **110** is used, the coaxial connector receptacle **110** is used in a state where an opening thereof faces upward. Thus, the upward direction in FIG. **6** is a direction towards the upper side in the vertical direction, and the downward direction in FIG. **6** is a direction towards the lower side in the vertical direction. Accordingly, the upward direction in FIG. **6** is defined as the positive side in the z-axis direction, and the downward direction in FIG. **6** is defined as the negative side in the z-axis direction.

The coaxial connector receptacle **110** is to be mounted on a circuit board such as a flexible printed circuit board, and as illustrated in FIG. **6**, the coaxial connector receptacle **110** includes the outer conductive unit **112**, the central conductive unit **114**, and the insulator **116**.

The outer conductive unit **112** is fabricated by performing punching and bending on a single metallic sheet (which is, for example, made of phosphor bronze) that has conductivity and elasticity. In addition, the outer conductive unit **112** is plated with nickel, silver, or gold. As illustrated in FIG. **6** and FIG. **7**, the outer conductive unit **112** includes an outer conductor **112***a* and outer terminals **112***b* to **112***d*. As illustrated in FIG. **6** and FIG. **7**, the outer conductor **112***a* has a shape that is substantially cylindrical and that extends in the z-axis direction.

The outer terminals **112***b* to **112***d* are connected to the outer conductor **112***a* and disposed on the negative side in the z-axis direction with respect to the outer conductor **112***a*. The outer terminal **112***b* is drawn out from the outer conductor **112***a* toward the negative side in the z-axis direction and bent toward the positive side in the y-axis direction. The outer terminal **112***c* is drawn out from the outer conductor **112***a* toward the negative side in the z-axis direction and bent toward the negative side in the x-axis direction. In addition, the outer terminal **112***c* has a substantially T-like shape when viewed in plan in the z-axis direction. The outer terminal **112***d* is drawn out from the outer conductor **112***a* toward the negative side in the z-axis direction and bent toward the positive side in the x-axis direction. In addition, the outer terminal **112***d* has a substantially T-like shape when viewed in plan in the z-axis direction.

The central conductive unit **114** is fabricated by performing punching and bending on a single metallic sheet (which is, for example, made of phosphor bronze). In addition, the central conductive unit **114** is plated with nickel, silver, or gold. As illustrated in FIG. **6** and FIG. **8**, the central conductive unit **114** includes a central conductor **114***a* and an outer terminal **114***b*.

As illustrated in FIG. **6**, the central conductor **114***a* is disposed at the center of the outer conductor **112***a* in such a manner as to extend in the z-axis direction. In other words, the central conductor **114***a* is surrounded by the outer conductor **112***a* when viewed in plan in the z-axis direction. As illustrated in FIG. **8**, the central conductor **114***a* has a substantially columnar shape that extends in the z-axis direction.

As illustrated in FIG. **6**, the outer terminal **114***b* is connected to an end portion of the central conductor **114***a* on the negative side in the z-axis direction and extends toward the negative side in the y-axis direction. As illustrated in FIG. **6**, the outer terminal **114***b* faces the outer conductor **112***b* with the center of the outer conductor **112***a* interposed therebetween when viewed in plan in the z-axis direction.

The insulator **116** is made of an insulating material such as a resin, and as illustrated in FIG. **6** and FIG. **9**, the insulator **116** has a substantially rectangular shape when viewed in plan in the z-axis direction. However, a cutout portion C**4** is formed in the insulator **116**. The cutout portion C**4** is formed by removing a center portion of a side of the insulator **116** on the positive side in the y-axis direction.

The outer conductive unit **112**, the central conductive unit **114**, and the insulator **116** are integrally molded by insert molding. With this configuration, the outer conductor **112***a* projects toward the positive side in the z-axis direction at the center of the insulator **116**. An end portion of the outer conductor **112***a* on the negative side in the z-axis direction is covered with the insulator **116**. The outer terminal **112***b* is drawn out outside the insulator **116** through the cutout portion C**4**. In addition, the outer terminals **112***c* and **112***d* are drawn out outside the insulator **116** from a side of the insulator **116** on the negative side in the x-axis direction and a side of the insulator **116** on the positive side in the x-axis direction, respectively. The central conductor **114***a* projects from the insulator **116** toward the positive side in the z-axis direction in an area surrounded by the outer conductor **112***a*. The outer terminal **114***b* is drawn out from the insulator **116** toward the negative side in the y-axis direction.

Mounting of Coaxial Connector Receptacle onto Coaxial Connector Plug

Mounting of the coaxial connector receptacle **110** onto the coaxial connector plug **10** will be described below with reference to FIG. **10** and FIG. **11**. FIG. **10** is a diagram illustrating the sectional structures of the coaxial connector plug **10** and the coaxial connector receptacle **110** before the coaxial connector receptacle **110** is mounted on the coaxial connector plug **10**. FIG. **11** is a diagram illustrating the sectional structures of the coaxial connector plug **10** and the coaxial connector receptacle **110** after the coaxial connector receptacle **110** has been mounted on the coaxial connector plug **10**.

As illustrated in FIG. **10**, the coaxial connector plug **10** is used in a state where an opening of the outer conductor **12***a* is oriented toward the negative side in the z-axis direction. As illustrated in FIG. **11**, the coaxial connector receptacle **110** is to be mounted on the coaxial connector plug **10** from the negative side in the z-axis direction. More specifically, the outer conductor **112***a* is to be inserted into the outer conductor **12***a* from the negative side in the z-axis direction. The diameter of the outer peripheral surface of the outer conductor **112***a* is set to be slightly larger than the diameter of the inner peripheral surface of the outer conductor **12***a*. Thus, the outer peripheral surface of the outer conductor **112***a* is pressed into contact with the inner peripheral surface of the outer conductor **12***a*, and the outer conductor **12***a* is pressed and made to expand in the horizontal direction by the outer conductor **112***a*. In other words, the outer conductor **12***a* expands in such a manner that the width of the entire cutting portion S

increases. Then, projections and depressions of the inner peripheral surface of the outer conductor **12***a* and projections and depressions of the outer peripheral surface of the outer conductor **112***a* engage with one another. As a result, the outer conductor **12***a* holds the outer conductor **112***a*. The outer conductors **12***a* and **112***a* are maintained at ground potential during use.

In addition, the central conductor **14***a* is to be connected to the central conductor **114***a*. More specifically, as illustrated in FIG. **11**, the central conductor **114***a* is to be inserted into the central conductor **14***a*, which has a substantially cylindrical-like shape. The diameter of the outer peripheral surface of the central conductor **114***a* is set to be slightly larger than the diameter of the inner peripheral surface of the central conductor **14***a*. Thus, the outer peripheral surface of the central conductor **114***a* is pressed into contact with the inner peripheral surface of the central conductor **14***a*, and the central conductor **14***a* is pressed and made to extend toward outside in the horizontal direction by the central conductor **114***a*. As a result, the central conductor **14***a* holds the central conductor **114***a*. A high-frequency signal current flows through the central conductors **14***a* and **114***a* during use.

Advantageous Effect

According to the coaxial connector plug **10** according to the present embodiment, the probability of the coaxial connector plug **10** easily separating from the coaxial connector receptacle **110** can be reduced. More specifically, in the coaxial connector plug **510** described in Japanese Unexamined Patent Application Publication No. 2013-118121, in the case of trying to reduce the height of the coaxial connector plug **510**, the height of the outer conductor **512***a* in the top-bottom direction decreases. However, in the case where the height of the outer conductor **512***a* in the top-bottom direction decreases, the rigidity of the outer conductor **512***a* decreases. Accordingly, the outer conductor **512***a* cannot be pressed into contact with the outer peripheral surface of the outer conductor of the coaxial connector receptacle with sufficient strength. As a result, the coaxial connector plug **510** easily separates from the coaxial connector receptacle.

Here, in the coaxial connector plug **10**, each of the outer terminals **12***e* and **12***f* is fixed to a land of a circuit board with solder or the like. Therefore, at the time of mounting the coaxial connector receptacle **110**, elastic deformation occurs in portions of the outer conductor **12***a* between the outer terminals **12***e* and **12***f* and the cutting portion S. Accordingly, in the coaxial connector plug **10**, as illustrated in FIG. **1** to FIG. **3**, the outer terminals **12***e* and **12***f* are disposed further toward the side on which the cutting portion S is formed than the straight line L**2** with the cutting portion S interposed therebetween when viewed in plan in the z-axis direction. Thus, the lengths of the portions of the outer conductor **12***a* between the outer terminals **12***e* and **12***f* and the cutting portion S are decreased. Therefore, it is not likely that elastic deformation will occur in the portions of the outer conductor **12***a* between the outer terminals **12***e* and **12***f* and the cutting portion S. As a result, the outer conductor **12***a* is strongly pressed into contact with the outer conductor **112***a*, and the probability of the coaxial connector plug **10** easily separating from the coaxial connector receptacle **110** can be reduced.

In addition, a reduction in the size of the coaxial connector plug **10** can be facilitated. More specifically, in the coaxial connector plug **10**, as illustrated in FIG. **1** to FIG. **3**, the outer terminals **12***e* and **12***f* are disposed further toward the side on which the cutting portion S is formed than the straight line L**2** with the cutting portion S interposed therebetween when viewed in plan in the z-axis direction. Thus, as illustrated in FIG. **3**, when viewed in plan in the y-axis direction, the outer terminals **12***c* and **12***d* do not project out from the outer conductor **12***a*. Therefore, the width of the coaxial connector plug **10** in the x-axis direction can be reduced. Since the outer terminal **14***b* extends toward the negative side in the y-axis direction, the outer terminal **14***b* does not project out from the outer conductor **12***a* when viewed in plan in the y-axis direction. Therefore, also from this standpoint, the width of the coaxial connector plug **10** in the x-axis direction can be reduced.

The coaxial connector plug **10** is fixed to a circuit board by the outer terminals **12***b* to **12***f*. Since the outer terminals **12***b* to **12***f* are connected to the outer conductor **12***a*, the outer conductor **12***a* is fixed in place at five points. On the other hand, in the coaxial connector plug **510**, the outer conductor **512***a* is fixed in place at three points. Therefore, the outer conductor **12***a* of the coaxial connector plug **10** is more resistant to elastic deformation than the outer conductor **512***a* of the coaxial connector plug **510**. Therefore, the probability of the coaxial connector plug **10** easily separating from the coaxial connector receptacle **110** can be reduced.

First Modification

A coaxial connector plug **10***a* according to a first modification will be described below with reference to FIG. **12** and FIG. **13**. FIG. **12** is an external perspective view of the coaxial connector plug **10***a* according to the first modification. FIG. **13** is a diagram illustrating the coaxial connector plug **10***a* according to the first modification when viewed in plan in the z-axis direction.

A difference from the coaxial connector plug **10** is that, in the coaxial connector plug **10***a*, the outer conductive unit **12** includes an outer terminal **12***g* instead of the outer terminals **12***c* and **12***d*. This difference will be mainly described below in the following description of the coaxial connector plug **10***a*.

The outer terminal **12***g* has a substantially T-like shape when viewed in plan in the z-axis direction. The outer terminal **12***g* is drawn out from the outer conductor **12***a* toward the negative side in the z-axis direction and bent toward the positive side in the y-axis direction.

Similarly to the coaxial connector plug **10**, also in the coaxial connector plug **10***a*, which has the above-described configuration, the probability of the coaxial connector plug **10***a* easily separating from the coaxial connector receptacle **110** can be reduced.

Second Modification

A coaxial connector plug **10***b* according to a second modification will be described below with reference to FIG. **14** and FIG. **15**. FIG. **14** is an external perspective view of the coaxial connector plug **10***b* according to the second modification. FIG. **15** is an external perspective view of the coaxial connector plug **10***b* according to the second modification during a process of manufacturing the coaxial connector plug **10***b*.

A difference between the coaxial connector plug **10***b* and the coaxial connector plug **10** is that, as illustrated in FIG. **14**, there is no gap in the cutting portion S. As described above, there is no gap in the cutting portion S, so that occurrence of variations in the inner diameter of the outer conductor **12***a* can be suppressed.

More specifically, when the outer conductive unit **12** is mounted onto the insulator **16**, as illustrated in FIG. **15**, the outer terminals **12***c* to **12***f* each of which is in an open state are caused to slide underneath the engagement portions **16***c* to **16***f* on the positive side in the z-axis direction, respectively, by applying pressure to the outer terminals **12***c* to **12***f* from both sides in the x-axis direction. In this case, the pressing force is also applied to the outer conductor **12***a*. However, since there is no gap in the cutting portion S in the coaxial connector plug

10*b*, even if deformation occurs in the outer conductor **12***a*, the size of a gap in the cutting portion S will not change. Therefore, in the coaxial connector plug **10***b*, occurrence of variations in the inner diameter of the outer conductor **12***a* can be suppressed.

In addition, in the coaxial connector plug **10***b*, the deformation that occurs in the outer conductor **12***a* when the outer conductive unit **12** is mounted on the insulator **16** is smaller compared with that in the coaxial connector plug **10**. Therefore, the pressing force, which has been applied to the outer terminals **12***c* to **12***f*, is not used for the deformation of the outer conductor **12***a* but used for the deformation of each of the outer terminals **12***c* to **12***f*. As a result, deformation occurs in the outer terminals **12***c* to **12***f* with more certainty.

Other Embodiments

The coaxial connector plug according to the present disclosure is not limited to the coaxial connector plugs **10**, **10***a*, and **10***b*, and modifications may be made within the scope of the present disclosure.

As described above, the present disclosure is useful in a coaxial connector plug, and in particular, the present disclosure has an advantage of reducing the probability of a coaxial connector plug easily separating from a coaxial connector receptacle.

While preferred embodiments of the disclosure have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the disclosure. The scope of the disclosure, therefore, is to be determined solely by the following claims.

What is claimed is:

1. A coaxial connector plug comprising:

a first outer conductive unit including:

a first outer conductor having a substantially ring-like shape in a portion of which a cutting portion is formed, when viewed in plan from above, along a first line that extends through a center of the first outer conductor, and

a first outer terminal and a second outer terminal drawn out downwardly from the first outer conductor; and

a first central conductive unit including a first central conductor disposed in an area surrounded by the first outer conductor when viewed in plan from above,

wherein, when viewed in plan from above, the cutting portion is interposed between the first outer terminal and the second outer terminal,

wherein the first outer terminal and the second outer terminal each includes a front edge that curves towards the first line, and

wherein the first outer terminal and the second outer terminal are entirely disposed, when viewed in plan from above, further toward a side on which the cutting portion is formed than a second line that is perpendicular to the first line and extends through the center of the first outer conductor.

2. The coaxial connector plug according to claim **1**,

wherein the first outer terminal and the second outer terminal project out from the first outer conductor in a direction different from a direction in which the second line extends when viewed in plan, in a direction in which the first line extends.

3. The coaxial connector plug according to claim **1**,

wherein when viewed in plan from above, the first outer terminal extends in a direction from the center of the first outer conductor toward a portion in which the first outer terminal and the first outer conductor are connected to each other and is bent to extend in a direction that is parallel to the first line, and

wherein when viewed in plan from above, the second outer terminal extends in a direction from the center of the first outer conductor toward a portion in which the second outer terminal and the first outer conductor are connected to each other and is bent to extend in a direction that is parallel to the first line.

4. The coaxial connector plug according to claim **1**,

wherein the first outer conductive unit includes a third outer terminal that extends in a direction opposite to a direction from the center of the first outer conductor toward the cutting portion when viewed in plan from above.

5. The coaxial connector plug according to claim **1**, further comprising:

a fourth outer terminal drawn out downwardly from the first outer conductor and disposed further toward a side opposite to the side on which the cutting portion is formed than the second line when viewed in plan from above; and

a fifth outer terminal drawn out downwardly from the first outer conductor and disposed further toward the side opposite to the side on which the cutting portion is formed than the second line when viewed in plan from above.

6. The coaxial connector plug according to claim **1**,

wherein the cutting portion is discontinuous.

7. The coaxial connector plug according to claim **1**,

wherein a substantially cylindrical second outer conductor of a coaxial connector receptacle is inserted into the first outer conductor, and

wherein a second central conductor of the coaxial connector receptacle is connected to the first central conductor.

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